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Working Paper 56

Unlocking the Potential of Administrative Data in Africa: Tax Compliance and Progressivity in Rwanda

Giulia Mascagni, Nara Monkam and Christopher Nell

October 2016

A joint paper by the International Centre for Tax and Development (ICTD) and the African Tax administration Forum (ATAF)

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For further information, please contact:

International Centre for Tax & Development
at the Institute of Development Studies, Brighton BN1 9RE, United Kingdom
T: +44 (0)1273 606261 E: info@ictd.ac W: www.ictd.ac

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For further information, please contact:

African Tax Administration Forum, Postnet Suite 430, Private Bag X15, Menlo Park, 0102 South Africa
T: +27 (0)12 451 8835 E: info@ataftax.org W: www.ataftax.org

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ICTD Working Paper 56
First published by the Institute of Development Studies in September 2016

ISBN: 978-1-78118-312-0

A catalogue record for this publication is available from the British Library.

Available from:
The International Centre for Tax and Development
at the Institute of Development Studies,
Brighton BN1 9RE, UK
Tel: +44 (0) 1273 606261 Fax: +44 (0) 1273 621202
E-mail: info@ictd.ac.uk
Web: www.ictd/en/publications

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Summary

This paper is the first in a series of three studies looking at tax compliance using administrative data from Rwanda. It discusses the use of administrative data for tax research – specifically anonymised taxpayers records, which have become increasingly available on the African continent. The paper starts by critically summarising the key advantages and disadvantages of using this data for tax research in Africa. It proceeds to illustrate these opportunities and challenges in practice, using the case of Rwanda for application of the data to analyse tax compliance and progressivity. By doing this it shows some stylised facts – for example that tax systems designed to be progressive can still be regressive in practice, that a great share of tax revenue is generated by a few very large taxpayers, and that some taxpayers face a negligible probability of being audited. Although these results are specific to Rwanda, they are in line with the situation in other low-income countries in Africa.

Keywords: administrative data; anonymised taxpayer records; tax compliance; progressivity; Rwanda.

Giulia Mascagni is Research Fellow at the Institute of Development Studies (IDS) and Research Director at the International Centre for Tax and Development (ICTD).

Nara Monkam is Director of Research at the African Tax Administration Forum (ATAF)

Christopher Nell was Research Officer at the Institute of Development Studies and the International Centre for Tax and Development, and now works as an independent consultant.

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Acknowledgements

This paper was produced with the support of the International Centre for Tax and Development (ICTD), which is financed by DFID and NORAD. We are very grateful for the invaluable support of the Rwanda Revenue Authority (RRA) throughout this project, which made it possible to complete this paper. In particular, the assistance of the RRA's Planning and Research Division has been crucial in the preparation of this paper. We would like to express our gratitude to the RRA's Commissioner General Mr Richard Tusabe, the RRA's Deputy Commissioner General Mr Pascal Ruganintwali, and the RRA's Deputy Commissioner for Research and Planning Mme Agnes Kanyangeyo for their high-level support of this project. We also owe very special thanks to Denis Mukama, John Karangwa, Gaudence Uwimana, Lucie Niyigena and Naphtal Hakizimana for their dedicated collaboration and for invaluable insights into the tax system of Rwanda. This paper would have not been possible without their inputs and support. We would also like to thank Remy Uwizera and his colleagues from the Application Software Division of the RRA for assisting us in accessing the data, as well as other RRA staff who have agreed to work with us and provided very useful inputs for our project.

Acronyms

ATAF	African Tax Administration Forum
ATRN	African Tax Research Network
CIT	Corporate Income Tax
EBM	Electronic billing machine
ETR	Effective tax rate
ICTD	International Centre for Tax and Development
PIT	Personal income tax
PAYE	Pay As You Earn
RRA	Rwanda Revenue Authority
TIN	Taxpayer identification number
VAT	Value Added Tax

Introduction

Revenue administrations across the globe routinely collect large amounts of data from taxpayers, both individuals and companies, in order to assess and raise tax revenue. This information consists of data on taxpayers' income and other relevant elements that affect their tax liability. For example, companies have to submit information on their business expenses in order to deduct them from taxable income. Individual taxpayers in many countries are frequently allowed to claim deductions for health care, charitable contributions, education, and so forth.

Although this data is collected for administrative purposes, it contains a wealth of information that can be used for research as well – for example on taxation, inequality and labour markets. In many high-income countries, administrative data from tax returns have been released to researchers in an anonymised format, so that taxpayer confidentiality can be preserved in accordance with the law. The availability of this data over time has sparked a lot of research – not least the recent work on income and wealth inequality summarised in Piketty's bestselling book *Capital in the Twenty-First Century* (Piketty 2014) and the thriving literature using field experiments to study tax compliance (reviewed in Mascagni 2016).

Despite the thriving research based on this type of data in high-income countries, as well as some middle-income ones in Latin America, many African countries have not fully unlocked its potential. This is partly due to younger revenue authorities on the continent, which have only undergone a process of modernisation and digitalisation in the past couple of decades. As a result, there is currently very little research using administrative data in Africa. However, recent efforts to link researchers with practitioners from revenue authorities have created momentum for research based on administrative data, and a few studies have recently been published.

Although the availability of administrative data in Africa certainly opens new opportunities for tax research, it comes with its own drawbacks. Against this backdrop, this paper has two objectives. The first one is to critically summarise the key advantages and disadvantages of using administrative data for tax research in Africa (Section 1). This summary can provide initial guidance for researchers intending to engage in this area. The second objective is to illustrate the opportunities and challenges in practice, by using the case of Rwanda for application of the data to analyse tax compliance and progressivity.

We chose to focus on compliance and progressivity in particular because they represent two of the biggest challenges that revenue authorities typically face in Africa. How to mobilise increasing revenue from all incomes, while still ensuring that the tax system is fair and equitable? Increasing tax compliance is particularly challenging for low-income countries for several reasons, including low capacity, a large informal sector and widespread poverty. In most countries, a successful revenue generation strategy needs to rely on a mix of encouraging voluntary, or quasi-voluntary, compliance, and enforcing tax laws. In low-income countries, where capacity constraints are particularly acute, coercion alone is not a feasible strategy to raise sufficient tax revenue. In this context, increasing compliance and achieving progressivity can be highly complementary objectives. When a tax system is perceived as being fair and progressive it is easier for the tax authority to convince taxpayers to pay their taxes quasi-voluntarily, without solely relying on costly audit and enforcement procedures.

Thanks to the collaboration with the Rwanda Revenue Authority (RRA), we were able to obtain administrative data for all domestic tax types in the country from 2012 to 2014.[1] This data is used to quantify some of the key aspects of compliance (Section 3.2) and progressivity (Section 3.3). By using information from anonymised tax returns, capturing real taxpaying behaviour, we can identify how the tax system works in practice as compared to the intention set out in the law. For instance, we show that although the personal income tax system is designed to be progressive, this is not always the case in practice. The results reported here, however, are purely descriptive of the Rwandan tax system, and represent a starting point for further research rather than conclusive evidence. This paper is the first output of a larger project on tax compliance based on administrative data from Rwanda, which also includes a large-scale experiment on the drivers of tax compliance.[2]

The paper is organised in three substantial sections, followed by some concluding remarks (Section 4). Section 1 introduces administrative data, discussing its main pros and cons – both generally and more specifically in the context of the analysis of tax compliance and progressivity. In doing this, this section also sets out the methods used for the subsequent descriptive analysis. While Section 2 gives an overview of the tax system of Rwanda, Section 3 reports the descriptive results from the application of administrative data to the issues of progressivity and compliance. In addition to analysing these two main issues of interest, we also report a description of the taxpayers in our sample (Section 3.1), which may provide useful facts for practitioners and other researchers interested in engaging in tax research in the country.

1 Data and methods

This section discusses administrative data and the questions that can be addressed using this type of data. Although most examples refer to Rwanda, we try to generalise the discussion to other African countries as well. Section 1.1 discusses the Rwandan data, including the process of anonymisation, matching of different datasets, as well as the variables included. Section 1.2 discusses more generally the advantages and disadvantages of administrative data, particularly as compared to studies based on surveys. On this basis, Sections 1.3 and 1.4 highlight the methodological implications of using administrative data in the analysis of compliance and progressivity.

1.1 Administrative data from anonymised tax returns

In May 2015 we collected administrative data from the RRA, both from anonymised tax returns and from audit reports. The former is available for all taxpayers, the latter only for those individuals or firms that are subject to an audit. This paper focuses particularly on the following taxes, which are discussed in more detail in Section 2: Personal Income Tax (PIT), Corporate Income Tax (CIT), Pay As You Earn (PAYE), and Value Added Tax (VAT). PIT and CIT data is available at the taxpayer level. In comparison, PAYE and VAT data are aggregated at the withholding agent level – the employer and the seller, respectively. Therefore, we do not have information on wages for each employee, or the amount of VAT that each consumer pays. In addition, we do not have complete individual data on excises and other tax types, such as property taxes. The full sample is composed of over 55,000

[1] The focus on domestic taxes follows the institutional separation in many revenue authorities, including the RRA, between domestic taxes and customs. Conceptually, domestic taxation could be argued to involve a more direct relation of accountability between the state and citizens, thus being more closely related to voluntary compliance and equity.

[2] The results of this large-scale experiment will be reported in a separate but related ICTD Working Paper (Mascagni et al. 2016b).

taxpayers observed between 2012 and 2014 (see Table 8 in the Appendix).[3] It has to be emphasised that this sample includes all active and registered taxpayers from all provinces in Rwanda who are subject to income taxes and/or VAT.

Although we obtained population-wide data from the RRA, there are two other alternatives for revenue authorities to engage in this type of research if they cannot (or are not willing to) share the complete dataset. The first possibility is to extract a random and nationally representative sample from the population data. The second option would be to share the population-wide data, but in clusters of taxpayers rather than for each individual. These clusters would be defined according to a relevant variable, for example income, that would also be used to rank them. An example of the latter approach is Fairfield and Jorratt (2014), who obtained data on the distribution of Chilean taxpayers in clusters of eleven taxpayers each from the Chilean revenue service.

Regardless of the access option adopted, administrative data has to be anonymised before being released to researchers. In the second option mentioned above, anonymisation happens automatically by clustering taxpayers. Nevertheless, this also imposes limits to the possible analysis that can be performed, because the resulting dataset is not fully disaggregated at the taxpayer level. Alternatively, revenue authorities can anonymise the data by deleting taxpayers' names from the dataset and replacing them with an identifier similar to the taxpayer identification number (TIN). The latter was the option adopted in the case of the Rwandan data used in this paper and in other research carried out in Ethiopia (Ali et al. 2015; Mascagni and Mengistu 2016). It is important for such identifiers to always be unique for the same taxpayer, so that data from separate records can be matched and accrued to the relevant taxpayer. For example, the unique identifier would allow researchers to match data from a firm's CIT declaration with data from VAT declarations filed by the same firm. It is important to emphasise that researchers are usually not interested in knowing the identity of specific taxpayers, but instead in using the data to calculate averages, investigate distributions and to identify patterns and trends. Therefore, research projects using administrative data can always be carried out without breaching the relevant laws on privacy and confidentiality.

Regarding the specific variables available in administrative data, researchers can potentially access all information included in tax declarations – with the exception of taxpayers' names. For income tax declarations filed by most large taxpayers, tax returns will include data on both income and expenses. For instance, firms need to declare their business income and any other income they may have received from auxiliary activities or investments performed by the firm. They also have to file detailed information about business expenses that can be deducted in the calculation of taxable income. Similarly, individuals are usually allowed to deduct certain types of expenses (e.g. related to healthcare), but only if they submit a declaration to the revenue authority. Most employees who just receive income through wages do not have to file declarations, but rather pay through their employers thanks to withholding procedures. On the other hand, VAT declarations typically contain less information, mostly related to the value of products sold and of inputs.

In the case of Rwanda, we obtained the full information available in the tax declarations, including turnover, costs of goods and services sold, gross profits, deductions, allowances and expenses. These are the key variables used for the analysis of progressivity and compliance. In addition, we also have information on the location of taxpayers according to the tax centre in which the firm is registered and obliged to pay its taxes. The registration of a firm by tax centre and the actual physical location, however, may not always be the same. A

[3] Our administrative dataset does not include firms operating in the informal sector, which made up roughly 40% of national income in Rwanda in 2007 according to an estimate by Schneider and Williams (2013).

disproportionate number of taxpayers are registered in tax centres located in the capital Kigali, which comprises, notably, all top-medium and large taxpayers of Rwanda.

Additionally, in the case of Rwanda we are able to observe revisions of tax declarations and whether they were made by the revenue authority (following an audit or other more informal checks) or by taxpayers themselves (e.g. when a taxpayer makes a change in their tax declaration after it was filed). Moreover, we also obtained data from RRA's audit department for those firms that were audited in 2014. However, this data does not always report the unique identifier that we need to match audit records with other background characteristics available in the tax returns. Therefore, in our analysis of compliance behaviour we use the data on revisions from the individual tax returns instead of those from the audit department. In doing so, we are implicitly using revisions done by the tax authority as a proxy for audits. However, strictly speaking, we cannot distinguish formal audits from any other type of enquiries, checks or investigations done by the RRA, sometimes referred to as 'desk audits', which still result in revision of tax liabilities by the tax authority. For the purposes of this paper this distinction has only a marginal importance, since we are interested in calculating audit probabilities in terms of the possibility that the revenue authority checks a taxpayer's account – regardless of it being a formal audit or a more informal investigation.

1.2 Pros and cons of using administrative data for research

The data for PIT and CIT is available at the taxpayer level, so, for each firm or individual, we know the amount of yearly income and tax paid, amongst others. However, the same level of disaggregation is not immediately available for PAYE and VAT, in Rwanda or many other low-income countries. For PAYE this is often due to failure to encode individual-level data in the digital records, although companies are required to file employee-level information to the revenue authority. Therefore, the disaggregated wage data is available in principle, but it requires some additional effort to be feasibly used for research.

The high level of disaggregation of administrative data is one of its key advantages, as compared particularly to macroeconomic data on tax payment and income. Thanks to this feature, it allows researchers to quantify variables such as compliance gaps or the tax burden for each taxpayer, and to identify variations among them. For example, we can answer questions like 'who faces the highest tax burden, the smallest or the largest taxpayers?', and 'is compliance higher for indirect taxes like VAT or for personal income taxes?'. Asking this kind of detailed question is more likely to yield specific recommendations to policymakers than exploring more general issues.

The closest alternative to administrative data, however, is certainly survey, rather than macroeconomic, data. Therefore, the advantages and disadvantages of administrative records are discussed here compared to surveys.

On a general level, there are three main advantages of administrative data over surveys. The first one is related to policy relevance. Using administrative data for research necessarily requires close collaboration with governments, because they collect and own the information. Therefore, policymakers from the revenue authority and/or the Ministry of Finance have to be consulted from the beginning of a project, having a chance to influence research questions and other aspects of the analysis. Because it would be harder to obtain access to data for issues that are completely irrelevant to policymakers, usually studies based on administrative data tend to be more connected with policymakers' needs and concerns. As a result, they also have a better chance of having a real impact and of being taken up in actual policies. This is reinforced by the fact that governments normally have more confidence in their own data than that collected by external organisations. This is also the data that is used for government operations and policymaking. For instance, aggregate revenue data from taxpayers' records is used in the budgeting and revenue monitoring processes. Importantly,

close collaboration with policymakers and practitioners offers invaluable opportunities for mutual learning. On one side, researchers can learn about the local context and the key policy issues in the country. On the other hand, officials can learn about research methods for rigorous evaluation, evidence-based policy formulation, and the potential for using their data – with the longer-term possibility to carry out further research 'in house'. However, using administrative data alone is not a guarantee for policy relevance, while studies based on other types of data, such as surveys, can clearly be highly policy relevant.

The second advantage is that administrative tax records often represent the longest available time series for many countries. Compared to surveys, they have the added benefit of being available for every year, rather than in intervals or even just for a specific point in time.

Thirdly, and perhaps most importantly, tax records can capture income more accurately than most other sources of data – although they still have drawbacks, as discussed below. One of the biggest challenges of surveys is that respondents often do not provide honest or accurate answers about income. Moreover, surveys often exclude very rich people either for statistical reasons (there are a small number of super rich in any given country), or for practical reasons – even when selected, very wealthy people are more likely to decline to participate (Atkinson et al. 2010; Alvaredo and Atkinson 2010; Atkinson 2011; Higgins and Lustig 2013). As a result, income data from surveys is often underreported or truncated. Therefore, without access to administrative data, researchers have often used imperfect proxies such as consumption, which surveys usually measure more accurately than income. However, consumption represents only a part of income, and a decreasing part as income increases (and savings and wealth increase). In other words, researchers using surveys can usually only obtain a limited and incomplete picture of the income distribution, without taking into account savings and investment. Related to this issue is the fact that surveys typically do not include information on how much tax is paid by each individual. Instead, researchers have to impute likely tax payments based on the proxy for income and assuming full take-up of all provisions of tax laws. The latter is a strong assumption, given that the literature has shown that taxpayers often do not fully benefit from tax provisions due to compliance costs (Coolidge 2012; Manoli and Turner 2014; Benzarti 2014). Administrative data can solve these problems because it includes information on declared income, with no need to find proxies, and actual tax payments.

However, administrative data also presents a few drawbacks, and two of the most important ones are precisely related to the measure of income. First, income data from tax returns only captures the information that taxpayers declare to the revenue authority. Therefore, all income from the informal economy, whether in the form of underreported income, full evasion, or entirely informal activities, is excluded. The only exception to this occurs with audits, to the extent that they can reveal true income. Still, audits are rare for small businesses (see Section 3.2.1) and fully informal firms that are not registered with the revenue authority. Despite this issue, there are methods that allow researchers to infer the level of compliance with administrative data, as discussed in Section 1.3.

Second, although administrative data captures all declared income, it is not always possible to match different sources of income that accrue to the same individual. For example, someone may earn wage income (subject to PAYE, withheld and paid by the employer), and income from independent work (subject to PIT, as declared by the taxpayer). These two sources of income can only be led back to the same individual if there is a unique identifier for that taxpayer. While this should be the case in principle in most countries, it frequently does not happen in practice. Many taxpayers have multiple TIN numbers for separate activities, making it very difficult or impossible to track them to the same person. This situation is particularly complex for wealthy individuals, who may have several sources of income and stakes in companies or funds, commonly in more than one country.

Another disadvantage of administrative data is that researchers often have no control over what information is collected. Only data that is needed for the purpose of tax assessment is available. Consequently, researchers frequently lack information on consumption patterns, household composition and other socio-economic characteristics. For example, the RRA does not ask taxpayers about their gender in the tax declaration. While in some cases gender can still be inferred using first names, if the revenue authority is willing to share them, this is not always feasible. In principle, more information could be obtained if all government departments used the same identifier for citizens. For example, in the United Kingdom most government services require the National Insurance number, which is unique for each person and could potentially be used to match, for instance, income tax data with healthcare records. However, this is a challenging exercise in high-income countries, and one that is very difficult to successfully implement in low-income countries.

Last, but not least, there is still resistance in many countries in Africa to granting researchers access to tax records. Government officials may be worried about breaching confidentiality rules. However, this is more due to lack of knowledge and experience on data sharing than to real constraints. As discussed above, administrative data can always be anonymised to comply with the relevant laws. Although researchers normally do not need to identify specific taxpayers, governments may feel that releasing administrative data can expose wealthy, and sometimes politically connected, individuals. This is a misperception: if the data is anonymised, researchers cannot trace specific individuals using their tax accounts. Moreover, revenue authorities could ask researchers to sign confidentiality agreements to further protect taxpayers' privacy, and to keep track of the research carried out using their data.

Beyond the advantages and disadvantages of administrative records compared to surveys, it is important to highlight that there is likely much to be gained by combining administrative and survey data. This includes, for example, the possibility of linking administrative data with socio-economic characteristics to establish a regional taxpayer footprint and labour market dynamics. Administrative data can also be used to validate survey outcomes and to characterise bias if those surveys are used to collect data on a section of the population that does not file tax declarations. On the other hand, surveys can also supplement administrative data by providing richer measures of household- and firm-level data. Often surveys and administrative data can be used in a complementary way, to address the same broad questions with different methods, or to tackle different research questions based on the comparative advantage of each source of information. Furthermore, there are substantial benefits that can be garnered from moving in the direction of assigning a single national identification number to each individual in the population; this will enable merging of various governmental data.

1.3 Methods to measure tax compliance using administrative data

Compliance is especially difficult to measure, because, by definition, those who are evading (i.e. not complying) are making active efforts to hide their behaviour. Few, if any, taxpayers would admit their wrongdoing to researchers, or, even less likely, to anyone related to the government. Researchers have circumvented this problem in various ways, for example through perception surveys, lab games, and field experiments (for a review, see Fjeldstad et al. 2012; Mascagni 2016). We would argue that the latter is the most reliable way to study actual compliance behaviour. This paper does not include an analysis of compliance using any of these methods, but this paper serves as a stepping stone for a large-scale field experiment that we carried out in Rwanda, the results of which are available in a separate paper (Mascagni et al. forthcoming b). Here, we simply provide a descriptive analysis of some key elements of compliance based on the information from administrative data. This serves as a basis for the more rigorous experimental research.

The first descriptive exercise we perform is to calculate audit probabilities, keeping in mind the caveat mentioned in Section 1.1 regarding the revisions data. Although the audit probability is not a measure of compliance, the literature has shown that it is one of its key determinants (Kleven et al. 2011; Alm 2012). Therefore, quantifying the probability of being caught by the revenue authority gives us an insight into compliance attitudes. If they are low, more taxpayers may be encouraged to evade on the grounds that they can reasonably expect to get away with it. Alternatively, revenue authorities may implement more audit efforts in sectors where compliance is low. We test these alternative hypotheses in the case of Rwanda.

Moreover, when audit data is available, as in the case of Rwanda, it is possible to directly measure the level of compliance. Other papers in the literature, such as Kleven et al. (2011), have used audit reports to this purpose. Audit reports allow the measurement of both declared and real income, the difference between the two being the amount of evasion or the compliance gap. In the case of Rwanda, we define the compliance gap as the difference between the pre- and post-revision tax liability as a ratio of the latter. However, it is worth noting that audits may not be able to uncover all unreported income, so even the revised amounts may still not capture total evasion.[4] Despite this caveat, we believe that they can be taken as a reasonable, though still imperfect, measure of non-compliance. More importantly, it must be taken into account that the compliance gap calculated in this way only considers the intensive margin (tax evasion of those who file returns), rather than the extensive margin (tax evasion of those who are not even registered).

It is not always straightforward in practice to infer the population's compliance level from audit reports, especially in low-income countries. This is because many countries do not have sufficient resources to carry out audits on a random sample of the taxpaying population that would be sufficiently large and nationally representative to allow for unbiased estimates. Countries like Rwanda, instead, can only afford to carry out a relatively small number of audits each year, and, thus, have to focus on those taxpayers that are more likely to evade. As a result, the audited group would generally be at higher risk of evasion and would not be representative of the whole population.

We try to overcome this problem by adopting three scenarios to estimate the compliance gap, with various underlying assumptions about the differences between the audited group and the whole population. The first one is called *lower bound*. It estimates the compliance gap as the total level of evaded tax divided by the total tax liability of all taxpayers. The main underlying assumption here is that the tax authority can audit all taxpayers that evade taxes, so that all the evasion that occurs in the economy is captured in the revisions data. Although this assumption is clearly not fulfilled in practice, it allows us to calculate the minimum amount of evasion that we know is certainly occurring in the country. Still, this calculation ignores all evasion occurring for those taxpayers that are completely informal – those that are not even registered at the RRA, even though they have some form of taxable economic activity.

The second scenario, named *upper bound*, determines the compliance gap as the average level of under-reporting divided by the average tax liability of the audited taxpayers. The underlying assumption here is that all taxpayers in Rwanda display the same degree of evasion as the sample of taxpayers that are audited. In other words, this scenario would occur if the RRA selected its audits randomly, so that the audited population is representative of the rest of the taxpayers. While a small share of the audits at RRA are chosen randomly (around 5 per cent), the likelihood of an audit also depends on the taxpayer's riskiness, based on factors such as turnover, previous audits, or the difference between the turnover

[4] This is particularly likely to be the case for so-called 'issue audits' that only look into a specific year or tax type for the audited taxpayer, and not any other aspect that is outside the scope of the issue being investigated.

declared on VAT and CIT. Therefore, the estimate of the upper bound scenario provides an estimate for the maximum level of non-compliance.[5]

The third scenario, called *upper bound weighted*, is similar to the previously described upper bound scenario. The only difference is that the compliance gap of each taxpayer is weighted by the share of its group (large and top-medium; small and medium in Kigali; or small and medium outside of Kigali) in the overall population. As a result, this scenario reflects the fact that the likelihood of an audit is different for large taxpayers, as well as for smaller taxpayers inside and outside of Kigali. Consequently, those groups with a relatively low audit rate but large taxpayer population receive a higher weight in the calculation of the compliance gap (as the gap is calculated from reporting behaviour of taxpayers who face an audit). The weighting procedure is particularly relevant because, as will be shown in Section 3.2.1, large taxpayers have a much higher probability of being selected for an audit.

It is important to mention that the lower bound, upper bound, and upper bound weighted all assume away the informal sector. In other words, these are lower bounds or upper bounds for the population of taxpayers that are operating in the formal sector and thus reporting to the tax authorities. Although none of these scenarios would precisely correspond to the true level of compliance in Rwanda, it still allows the computation of a range within which we expect true compliance.

The analysis on compliance in Section 3.2 uses only pooled data of the years 2012 and 2013, since a major restructuring occurred at RRA in 2014, which had a large impact on audits. In particular, financial and human resources were temporarily shifted from audit to tax enforcement in 2014, and, hence, only few audits were conducted in that year. As these low audit efforts would have skewed the tax compliance figures, we decided to restrict our compliance analysis to 2012 and 2013.

Finally, Section 3.2.3 briefly describes the population of nil-filers and taxpayers that are reporting losses. Although this is not a measure of compliance, it may still capture some aspects of compliance behaviour. Nil filers are taxpayers who submit a declaration with zero taxable income. A key reason for nil-filing is to avoid fines for not filing, while still benefiting from a zero tax liability. As such, although nil-filers are registered with the RRA and file returns, they may still be non-compliant if their true income is larger than zero. Therefore, nil-filing is likely to be an indication of individual compliance behaviour. Similar to nil-filers, some taxpayers may declare negative income (i.e. losses), either because they are genuinely losing in their business or because they are underestimating income or overestimating costs – either way resulting in under-reported taxable income. Section 3.2.3 provides some descriptive statistics on the prevalence of these phenomena by tax type, taxpayer size, and location. Nil-filers and firms with losses are instead excluded from the subsequent analysis on tax progressivity since, as will be explained in the next section, that analysis requires positive income.

1.4 Methods for analysing progressivity with administrative data

The analysis of progressivity is concerned with the distributive effects of taxation, asking for example whether a certain tax bears unfairly on the poor rather than on the rich. A progressive tax system is one in which people at the top of the income distribution pay more as a proportion of their income than those at the bottom. On the one hand, most personal income tax systems are designed to be progressive, thanks to a set of rates that increase as income increases. On the other hand, indirect taxes are often levied according to a flat rate that is applied regardless of the level of income of the consumer.

[5] In the unlikely event that random selection is more likely to detect under-reporting than RRA's formula to select audit, the actual level of evasion is even higher than indicated in the upper bound scenario.

However, taxes that are progressive (e.g. income) or proportional (e.g. VAT) on paper can still have regressive effects in practice. Researchers have analysed the *de facto* progressivity of taxation with various methods. As far as indirect taxes are concerned, the most common one is incidence analysis, which looks at how consumption taxes affect individuals through higher prices. Incidence of indirect taxes depends both on the tax rates applied to various goods, and on the quantity of each good that is consumed by each individual or household. These studies are usually based on surveys, because the latter include the necessary information on consumption and other household characteristics. In comparison, administrative data, for example on VAT, does not allow the identification of the consumers bearing the tax burden, but only of the withholding agents (i.e. businesses) that make the final payment to the revenue administration.

Therefore, our distributional analysis in Section 3.3 concentrates on income subject to PIT and CIT. The main reason for this is the unavailability of PAYE and VAT data at the necessary level of disaggregation. As discussed in Section 1.2, data on PAYE is only available at the firm level. For example, for each firm we potentially know the total number of employees and the total tax paid for all of them. Similarly, VAT is collected by companies, while the final consumer bears the tax burden. Administrative data can be disaggregated at the level of firms that withhold VAT, but not at the consumer level. We are therefore unable to investigate the distributional impacts of VAT with our available dataset.

Notwithstanding its limitations in analysing the progressivity of indirect taxation, administrative data can be more useful for income taxes. Researchers have looked at the distributional effects of income taxation using standard tools of distributional analysis, such as the Gini index or income ratios,[6] which can be calculated before and after taxes. An improvement in these indexes after taxes can be interpreted as an indicator that the system is progressive. These indexes can be calculated with administrative data, but it is usually difficult to obtain a measure of overall income for each taxpayer because of the reasons discussed in Section 1.2. We do not attempt such an aggregation of overall income in Rwanda.

The method we employ here is to calculate effective tax rates (ETRs) for each decile of income, thus getting an overview of the tax burden across the distribution. If the tax burden increases in higher deciles, the tax can be seen as being progressive. The ETR reflects the amount that each taxpayer pays in taxes as a share of income, and is defined here as the ratio of the tax due over overall income.[7] ETRs are calculated only for taxpayers with a positive amount of income. It is important to note that the resulting ETRs are expected to be substantially lower than the statutory tax rates (reported in Table 1), because the denominator here is overall income instead of taxable income. Doing this allows us to compare taxpayers under different tax regimes (described in Section 2), since all of them include overall income as a minimum reporting requirement. In addition, ETRs can reveal differences in the way different businesses (individuals or corporates) exploit existing provisions in the law, or even adopt aggressive tax minimising strategies to decrease their tax burden.[8]

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6 Income ratios are frequently defined as the ratio of the income of the richest 10% (20%) of taxpayers to the poorest 10% (20%), and are sometimes used as an alternative measure of inequality to the Gini index.

7 Overall income in the flat-amount regimes refers to business income, reflecting the value of sales from the business activity of the firm. In comparison, overall income in the lump-sum regime indicates business and transport income. Overall income in the CIT real regime additionally includes rental income, investment income (from dividends, royalties, service fees, performance payments, lottery and gambling), and non-operating and extraordinary income (see RRA 2014: Article 44). In addition to the items of the CIT real regime, overall income in the PIT real regime contains employment income (such as wages, salaries, fees, allowances and pension payments; see RRA 2014: Articles 34–36). See Section 2 for an explanation of the different regimes.

8 A full description of the methods available to compute ETRs is beyond the scope of this paper. However, the interested reader can refer to, for example, Lazar (2014), Nicodeme (2002) and Søresen (2004).

Deciles are calculated separately for each year and for each regime type. This is done to avoid all taxpayers in the flat-amount and lump-sum regimes falling in the bottom deciles, and to gain additional insights about the respective tax burden of different sized taxpayers in a given regime. Deciles are only calculated for businesses with positive income. We do not specify deciles for the CIT flat-amount and lump-sum regimes due to the low number of firms classified in these two regimes (accounting for only 2.6 per cent of total CIT revenue from 2012 to 2014; see Figure 4 in Section 3.1).

2 Setting the context: the tax system in Rwanda

This section provides an overview of the tax system in Rwanda, as a basis for the analysis of compliance and progressivity. As anticipated in the Introduction, it focuses particularly on domestic taxation, therefore excluding revenue from customs, but including both direct and indirect domestic tax types.

As far as direct taxes are concerned, Rwanda makes use of three main types of income tax: Personal Income Tax (PIT), Corporate Income Tax (CIT), and Pay As You Earn (PAYE).[9] PIT is often framed as a tax on individual businesses. Depending on the size of turnover, these businesses are categorised into one of the following three regimes: 1) the real regime, 2) the lump-sum regime, and 3) the flat-amount regime. Large businesses are in the PIT real regime and have to provide full books of accounts to the revenue authority, while smaller businesses face less stringent bookkeeping requirements. All taxpayers have to submit their annual PIT returns, including supporting documents, and pay their tax due no later than 31 March of the following tax period. The tax rate in the PIT real regime follows a progressive structure and depends on annual taxable income. Income below RWF 360,000 is exempted from taxation. Income between RWF 360,001 and RWF 1,200,000 is taxed at 20 per cent, while for higher income a tax of 30 per cent is applied. Small enterprises (turnover between RWF 12 million and RWF 50 million per tax period) are subject to a lump-sum tax of 3 per cent of their turnover. Nevertheless, small firms can voluntarily opt for the real regime, which is subject to stricter bookkeeping regulations. Microenterprises generating a turnover of more than RWF 2 million and less than RWF 12 million have to pay a flat amount between RWF 60,000 and RWF 300,000, depending on their income (RRA 2014: Articles 11 and 12).

CIT is a tax on income generated from corporate business activities, which has to be declared annually before April of the following tax period. While CIT is levied at a flat rate of 30 per cent, the tax rate is reduced for businesses less than five years old, depending on how many shares the public possesses. The tax rate is 20 per cent if the public holds at least 40 per cent of the shares, 25 per cent if at least 30 per cent is public, and 28 per cent if at least 20 per cent is public (RRA 2014: Articles 41 to 43). In spite of corporations usually having a higher turnover than individual businesses subject to PIT, a few smaller taxpayers are incorporated and thus they are included in our study. Similar to PIT, these small corporations are subject to a lump-sum tax of 3 per cent of turnover, while microenterprises have to pay a flat amount between RWF 60,000 and RWF 300,000, as classified by turnover.

PAYE is a withholding tax paid by the employer for its employees on monthly employment income. Taxpayers with turnover higher than RWF 200 million have to file their tax returns

[9] Withholding procedures are in place to collect some of these income taxes. In particular, there is a withholding tax of 3% on public tenders and 5% on imported goods. Moreover, a withholding tax of 15% on other payments is levied on dividends, interest, royalties, service fees, performance payments to artists, sportspersons, musicians, and lotteries, and goods supplied by unregistered companies (RRA 2014: Article 51).

monthly. Smaller taxpayers file quarterly, unless they voluntarily opt for monthly filings. In general, the declarations have to be submitted within fifteen days after the end of the respective filing period. PAYE has a progressive structure, where the tax brackets and tax rates are identical to those of the PIT real regime. Nevertheless, casual workers earning more than RWF 30,000 a month are taxed at 15 per cent of taxable income (RRA 2014: Articles 17 and 50).

As far as domestic indirect taxes are concerned, RRA collects both VAT and excise taxes. The filing periods and declaration deadlines for VAT are regulated in the same manner as for PAYE – taxpayers with turnover higher than RWF 200 million file monthly, while smaller taxpayers generally file quarterly. Both small and large taxpayers have to submit their VAT declarations within fifteen days after the end of the respective VAT filing period. The standard VAT rate is 18 per cent, but a rate of 0 per cent is levied on export goods and services, clean water suppliers, goods related to health and medical services, educational services, energy saving lamps and a few other goods specified in the law (RRA 2014: Articles 5 and 25).

Table 1 gives an overview of Rwanda's tax types and tax rates. The first column shows the tax type, the second column the respective tax rates, and the third column the total tax revenue generated from a given tax type in the fiscal year 2013/14.[10] For example, in column (3) of Table 1 we see that both PIT and CIT generate revenue higher than RWF 35 billion each.

Table 1 Domestic taxes in Rwanda

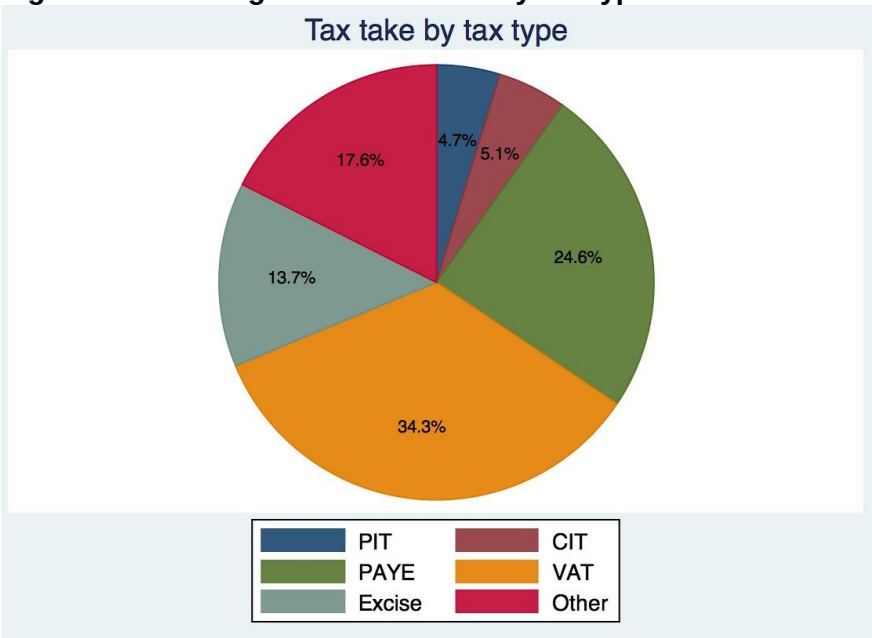
(1) Tax type	(2) Tax rates	(3) Tax revenue (million RWF)
Direct Taxes		
PIT	Real regime: 0% (below RWF 360,000) 20% (between RWF 360,001 and RWF 1,200,000) 30% (above RWF 1,200,000) of taxable income Lump-sum regime: 3% of turnover for small companies Flat-amount regime: Pre-defined amounts for micro companies, depending on turnover	35,627
CIT	30% for real regime 3% of turnover for small companies Flat amount for micro companies	38,615
PAYE	Progressive structure: 0%, 20%, 30% of wages	185,886
Indirect taxes		
VAT	0% or 18% (standard rate)	259,129
Excise taxes	Between 5% and 150%	103,449

Notes: The reported figures are based on data from the Ministry of Finance and Economic Planning. The CIT rate is reduced to 20%, 25% or 28% for enterprises less than five years old if the public holds at least 40%, 25% or 20%, respectively. The PAYE rate for casual workers is 15% of taxable income if their income exceeds RWF 30,000 per month.

[10] The macro data on tax revenue was obtained from the Ministry of Finance and Economic Planning of the Republic of Rwanda.

Figure 1 displays the tax revenue from the tax type as a share of total tax revenue in 2013/14. PIT contributes 4.7 per cent, CIT 5.1 per cent and PAYE up to 24.6 per cent of total tax revenue. Figure 1 further shows that the highest tax revenue in Rwanda comes from VAT payments, which generate 34.3 per cent of total revenue.[11]

Figure 1 Percentage of tax revenue by tax type in 2013/14



Notes: Authors' calculations based on data from the Ministry of Finance and Economic Planning. The category 'Other' includes revenue from property taxes, road fund and taxes on international trade.

3 Results

3.1 Descriptive analysis of tax revenue

Although the main analysis is concerned with compliance and progressivity, we begin with a more general description of tax revenue according to the size of the firms, the respective regime types (where applicable), and the regional distribution of revenue based on the location of the tax centres.[12]

Figure 2 displays the share of tax revenue contributed by small and large firms, defined according to RRA's classification. The figure takes into account contributions from PIT, CIT, VAT and PAYE, and shows that the RRA is highly reliant on income from large and top-medium sized taxpayers who account for 71 per cent of total tax revenue. Large and top-medium taxpayers are classified by RRA according to turnover or overall income, where the majority of large taxpayers are subject to CIT. The average PIT overall income is RWF 15.7 million, while the average CIT overall income is more than RWF 225 million. Furthermore, taxpayers in the CIT regime pay on average about RWF 3 million on taxes, while taxpayers in the PIT regime are liable for less than RWF 157,000 on average (full sample).

[11] While excise tax is responsible for almost 13.7% of tax revenue in 2013/14, we do not further analyse this tax type due to incomplete micro-level data. Rwanda uses a number of excise taxes levied on consumption goods such as cigarettes (150%), liquor (70%), wine (70%), beer (60%), lemonades and other juices (39%), mineral water (10%) and fruit juices (5%). The excise tax has to be paid and declared within five days after the end of the respective filing period (three intervals per month), while the excise tax on imports has to be cleared instantly with custom duties (RRA 2014: Articles 4, 9 and 10).

[12] While our available data does not provide information on sector activity of the firms and gender of the taxpayers, a future study may also investigate differences in the tax burden and compliance rates across sectors and gender.

Figure 2 Tax take by size (2012 to 2014)

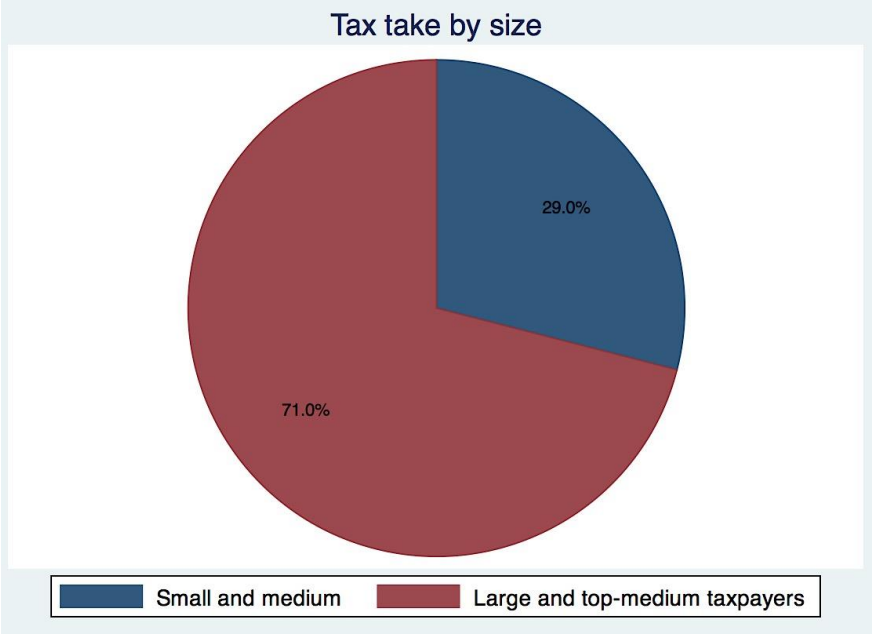
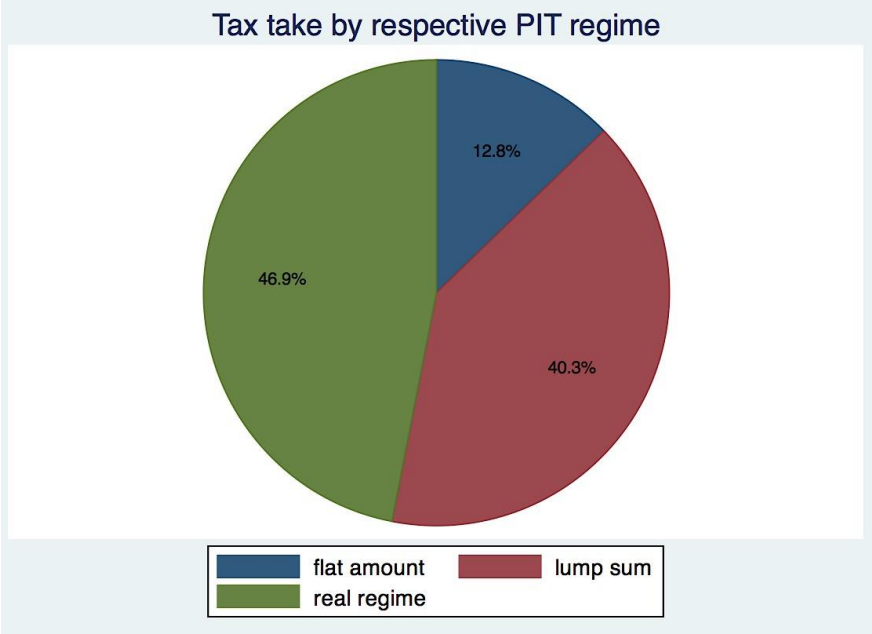


Figure 3 summarises the share of tax revenue of the respective PIT regimes for the fiscal years 2012 to 2014. We see that the highest PIT revenue stems from the lump-sum and real regimes with 40.3 per cent and 46.9 per cent, respectively. The PIT flat-amount regime still contributes considerable revenue, accounting for 12.8 per cent of total PIT revenue, but substantially less than the other schemes. Figure 4 shows the tax take of the corresponding CIT regimes for the same period. Almost all CIT revenue is from the real regime, contributing more than 97 per cent of total collection. Given this low tax revenue from the CIT lump-sum and flat-amount regimes, the remainder of this paper will focus on analysing compliance and progressivity of the CIT real regime.[13]

Figure 3 Tax take by PIT regime (2012 to 2014)



[13] The shares of the tax take from the regimes shown in Figure 3 and Figure 4 are identical for the sample of firms with positive income and the *full* sample.

Figure 4 Tax take by CIT regime (2012 to 2014)

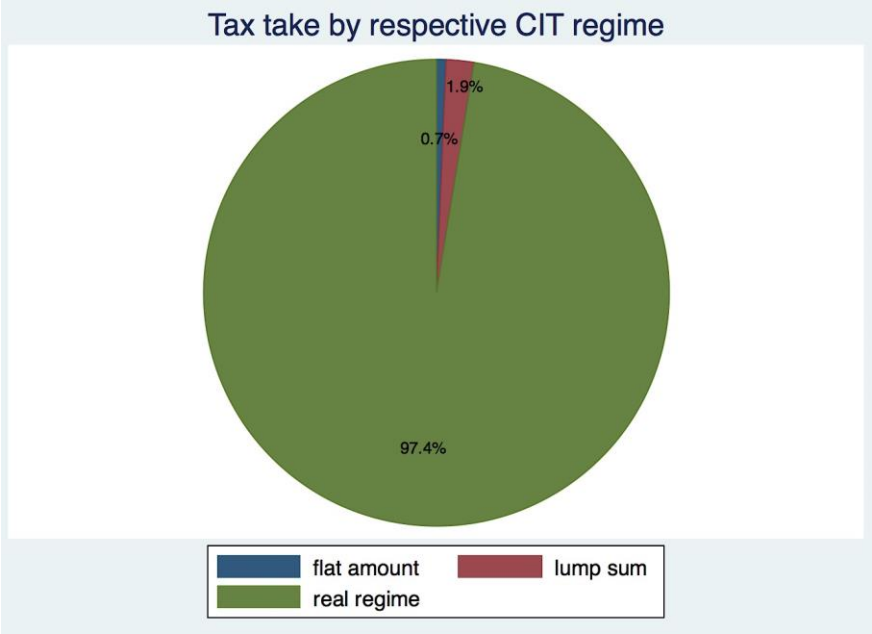


Table 2 shows the tax take by decile for a given regime for the years 2012 to 2014. The analysis only includes taxpayers with positive income, and the deciles are based on overall income (as discussed in Section 1.4). For example, column (1) of Table 2 shows that 7.5 per cent of total revenue in the PIT flat-amount regime comes from the lowest (first) decile. The tax revenue in the flat-amount regime is comparatively more evenly distributed across deciles, which is a result of the fixed amount to be paid (RWF 60,000 or RWF 300,000, depending on income – see Section 2). In comparison, most revenue in the real regimes comes from the top deciles. Column (3) (last row) indicates that the richest decile in the PIT real regime contributes almost 60 per cent of total PIT revenue in this regime, while the top income decile in the CIT real regime accounts for nearly 85 per cent (last row of column (4)). Almost 24 per cent of total revenue of the PIT real regime is from the richest 1 per cent. Further, more than of 56 per cent of CIT real regime revenue is from the richest 1 per cent – corresponding to just about 85 large corporations.[14] In other words, CIT tax revenue and, to a lesser extent, PIT revenue are highly reliant on a few large taxpayers.

Table 2 Tax contribution by decile as % of total regime revenue (2012 to 2014)

Decile	(1) PIT flat amount	(2) PIT lump sum	(3) PIT real	(4) CIT real
1	7.5	1.1	0.7	0.1
2	7.7	1.7	0.8	0.2
3	7.8	2.6	1.1	0.3
4	7.8	3.7	1.6	0.4
5	7.7	5.2	2.9	0.7
6	7.8	6.3	4.9	1.3
7	7.9	6.6	7.2	1.7
8	7.9	8.5	8.7	3.2
9	14.4	17.0	13.1	7.3
10	23.5	46.3	59.6	84.8

Notes: For each regime, the deciles are calculated on the basis of PIT or CIT overall income. In column (1) tax contributions are measured as a share of total PIT revenue of the flat-amount regime. In column (2) tax contributions are measured as a share of total PIT revenue of the lump-sum regime, and in column (3) as a share of total PIT revenue of the real regime. Column (4) shows tax contributions as a share of total CIT revenue of the real regime.

[14] The results for the top 1% are not shown in Table 2, but they are available from the authors.

Figure 5 and Figure 6 show the share of taxpayers as well as the regional distribution of revenue based on the location of the tax centres. As regional distribution refers to the registration of the taxpayer, it does not necessarily reflect the geographical location of the firm. For instance, all large and top-medium taxpayers are registered in Kigali, independently of the actual physical location of the business. Even though the share of taxpayers registered outside the province of Kigali is 56 per cent (see Figure 5), only a small share of the tax take of the RRA comes from these taxpayers. From 2012 to 2014, taxpayers outside the province of Kigali were responsible for merely 14 per cent of the tax revenue from PIT, CIT, VAT and PAYE (see Figure 6), while Kigali accounted for 86 per cent of revenue. In other words, taxpayers registered in the tax centres of Kigali contribute a high share of tax revenue. However, this high share is mainly due to all large and top-medium firms registered in Kigali, accounting for 71 per cent of total revenue (see Figure 2 above).

Figure 5 Number of taxpayers by tax centre (2012 to 2014)

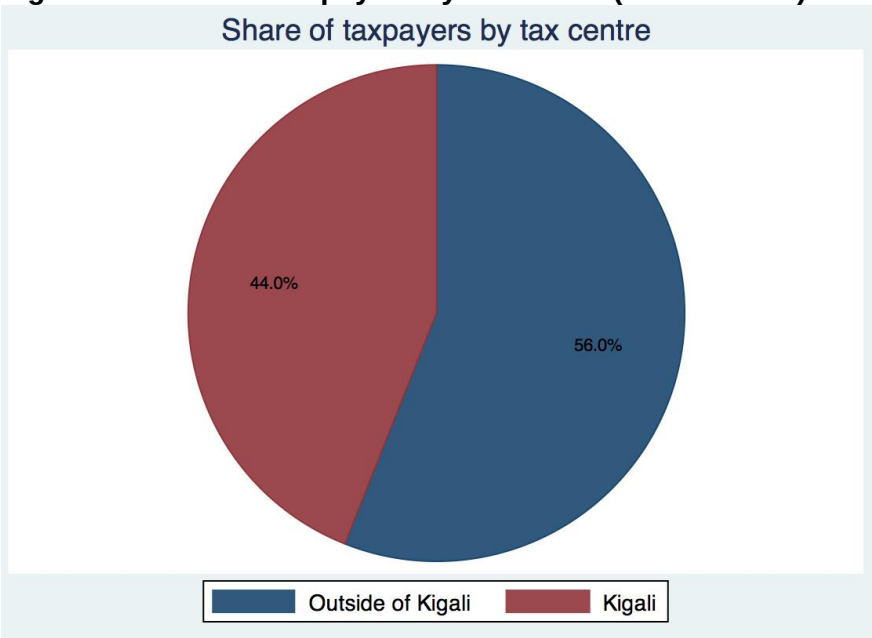
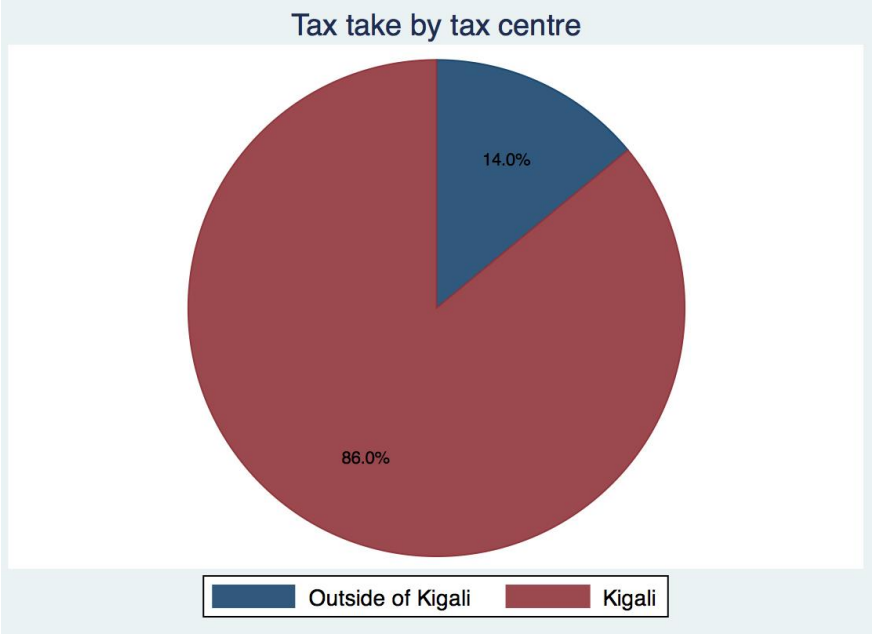


Figure 6 Tax take by tax centre (2012 to 2014)



3.2 Compliance

3.2.1 Audit probability

Following the methods outlined in Section 1.3, we compute audit probabilities for Rwandan taxpayers. Column (1) of Table 3 summarises the share of tax declarations that were revised by the tax authority in calendar year 2013, and column (2) of Table 3 shows the corresponding average level of misreporting. As discussed in Section 1.1, the revisions by the authority do not only include formal comprehensive and issue audits, but also revisions of declarations that result from enquiries by taxpayers or informal checks such as desk audits. Therefore, the probabilities calculated here may overestimate the probability of facing a formal audit, as they also include other checks and investigations. From RRA's audit records we know that about 400 audits are carried out in a typical year – a very small number.[15] However, as argued in Section 1.1, the distinction between formal audits and informal checks matters only marginally for the purpose of this descriptive investigation.

Table 3 Revisions by authority and level of under-reporting (2013)

	(1) Revisions by authority (%)	(2) Average level of under-reporting (RWF)
PIT real regime	2.3	107,253
PIT lump sum	0.4	2,118
PIT flat amount	0.1	1,868
CIT real regime	1.4	201,605
CIT lump sum	0.3	800
CIT flat amount	0.0	37
VAT	8.4	510,699
PAYE	0.8	31,137
Large and top-medium	20.0	4,230,153
Small and medium, Kigali	2.2	96,574
Small and medium, outside Kigali	0.1	13,801

Note: Column (1) reflects all tax declarations revised by the authority (e.g. comprehensive, issue, desk audits etc.) and column (2) shows the average level of under-reporting of taxable income detected by the RRA in the calendar year 2013. The bottom three categories (i.e. large and top-medium; small and medium, Kigali; small and medium, outside Kigali) refer to tax declarations from CIT, PIT, VAT, and PAYE. The figures are based on the full sample.

The figures in Table 3 show three important general facts. Firstly, audits and other checks have a much higher incidence in the group of large and top-medium taxpayers (20 per cent are audited), while they are negligible for smaller taxpayers outside of Kigali (0.1 per cent). The average level of under-reporting in the former group is more than RWF 4 million, where misreporting refers to CIT, PIT, VAT, and/or PAYE in the calendar year 2013. Secondly, audits are largely concentrated in the province of Kigali. However, this low number of RRA revisions outside of Kigali is partially a consequence of all large and top-medium firms being registered in Kigali, while their physical location could be outside of the capital city (see Section 2).

Thirdly, VAT is investigated much more commonly (more than 8 per cent of the firms) than other tax types, with PIT and CIT real regimes being revised by RRA only in 2.3 per cent and 1.4 per cent of the cases, respectively. The average level of misreported VAT due is more than RWF 500,000 (see third panel of Table 3). This relatively high level can be explained by at least two factors. First, large taxpayers with high turnovers are usually registered for VAT,

[15] For example, the RRA's business plan for 2015/16 suggests that the audit department investigates 120 large and 260 small and medium taxpayers.

and are also typically more likely to be subject to an audit, as shown in column (1) of Table 3. Second, the higher frequency of VAT revisions by the RRA may reflect higher enforcement pressure in this tax type. This is consistent with the recent introduction of electronic billing machines (EBMs) in 2013, aimed precisely to increase tax compliance. A recent paper on EBM in Rwanda shows that there has been a sharp increase in EBM users from 306 taxpayers in the first quarter of 2013, to 924 taxpayers in the last quarter of the same year (Eissa et al. 2014). By the third quarter of 2014, there were already 3,943 registered EBM users, which constituted 77.8 per cent of the sample of their study. The unfamiliarity of taxpayers with the EBM machines, as well as the transmission of transaction records to the revenue authority in real time, which makes tax evasion more difficult, may have contributed to the relatively high share of VAT revisions done by the RRA.

As far as direct taxes are concerned, column (1) of Table 3 shows that the highest share of revisions by the authority is for the PIT and CIT real regimes (2.3 per cent and 1.4 per cent, respectively). The average level of under-reporting of taxable income in the PIT real regime is close to RWF 110,000 and higher than RWF 200,000 in the CIT real regime. This is consistent with CIT taxpayers being generally larger businesses. In contrast, revisions in the lump-sum and flat-amount regimes are relatively rare and are restricted to informal checks by the tax authority, such as desk audits. As a result, the levels of under-reporting of income in the lump-sum and flat-amount regimes are considerably lower (between approximately RWF 40 and RWF 2,100). This confirms the idea that taxpayers in the lump-sum and flat-amount regimes can feel somewhat 'protected' against audits, since the RRA rarely conduct formal investigations for these regimes (see low RRA revisions of these regimes in column (1) of Table 3). Therefore, the analysis of the compliance gap below will not use audit data from taxpayers in the CIT and PIT lump-sum and flat-amount regimes.[16]

Taken together, these facts mean that a small taxpayer who files exclusively for PIT or CIT and is not registered in Kigali has a negligible probability of being audited. More generally, RRA revises less than 1 per cent of total PIT, CIT, and PAYE declarations. While these audit rates may appear low, they are similar to the rates in OECD countries such as the USA, where it was 0.8 per cent in 1990 and 1.7 per cent in 1995 (Andreoni et al. 1998).

3.2.2 Compliance gaps

We now present three alternative measures of the compliance gap, according to the methods described in Section 1.3. The compliance gap is defined as the ratio of the average evaded tax to the (assumed) true tax liabilities.

The first and second columns of Table 4 reflect the compliance gap under the lower and upper bound scenarios for the tax period 2012 to 2013.[17] The compliance gap for the PIT real regime is estimated to be between 4.6 per cent and 64.5 per cent, while the estimated non-compliance in the CIT real regime is between 3.1 per cent and 67.4 per cent. Although the RWF amount of under-reporting is generally higher for VAT than for other taxes (see Table 3), non-compliance is much lower than for other tax types in percentage terms, with an

[16] Investigating taxable income in the PIT lump-sum regime, it seems that a lot of individuals indicate round numbers (e.g. RWF 1 million, RWF 2 million). As may be expected, there is no bunching (i.e. concentration of declared income) at the threshold income to be subject to the real regime of RWF 50 million (see Section 1 for the thresholds). Taxpayers with income below RWF 12 million have to pay a flat amount. Even though there is a higher number of taxpayers with RWF 12 million (34 taxpayers) than, say, with RWF 11 or RWF 13 million (9 and 13 taxpayers), there are other incomes which are considerably more common (e.g. RWF 2 million). Moreover, the large majority of PIT lump-sum taxpayers in 2014 had a taxable income lower than RWF 12 million, and, thus, they would qualify as microenterprise subject to the flat-amount regime in the next tax period. While there are a lot of firms at the PIT flat-amount regime indicating an income of RWF 2 million, these taxpayers still have to pay RWF 60,000, which is the lowest rate in the flat-amount regime (applied to turnovers from RWF 2 to 12 million).

[17] The actual audit may have taken place in a different year than 2012 or 2013, since the RRA can audit tax declarations up to five years after the original declaration. For example, the RRA can audit tax returns for the period 2010 until calendar year 2015.

estimated maximum compliance gap of 38.3 per cent. This can probably be explained by similar reasons to those given before. Firstly, large taxpayers are more likely to be registered for and declare VAT. Although the amounts involved are high, hence the large figures in RWF, the proportion of under-reporting can still be small when tax bills are large – as is normally the case for large companies. Second, VAT accounts are more likely to be audited, and, thus, taxpayers may experience a higher enforcement pressure. This could lead them to evade less, as a proportion of tax due. Another implication of more frequent audits for VAT is that audited VAT taxpayers may be more similar to the rest of the population and thus potentially be more representative (which is an assumption in the calculation of the upper-bound scenario).

Table 4 Compliance gap (%, 2012 and 2013)

	(1) Scenario: lower bound	(2) Scenario: upper bound	(3) Scenario: upper bound weighted
PIT real regime	**4.6**	**64.5**	**72.6**
Large and top-medium	3.1	49.5	
Small and medium, Kigali	7.0	84.0	
Small and medium, outside Kigali	3.5	49.9	
CIT real regime	**3.1**	**67.4**	**72.0**
Large and top-medium	2.5	65.7	
Small and medium, Kigali	8.2	76.2	
Small and medium, outside Kigali	0.5	12.8	
VAT	**4.0**	**23.9**	**38.3**
Large and top-medium	2.1	15.4	
Small and medium, Kigali	12.3	49.6	
Small and medium, outside Kigali	10.9	23.1	
PAYE	**0.1**	**2.0**	**1.8**
Large and top-medium	0.1	2.0	
Small and medium, Kigali	0.1	4.2	
Small and medium, outside Kigali	0.0	–0.2	

Note: Column (1) defines the compliance gap as the total level of under-reporting divided by the total tax due of *all* taxpayers. Column (2) defines the compliance gap as the average level of under-reporting divided by the average tax due of the *audited* taxpayers. Column (3) defines the compliance gap as the level of under-reporting divided by the tax due of the audited taxpayers weighted by the respective share of the taxpayer's population (large and top-medium; small and medium, Kigali; small and medium, outside of Kigali). The figures are based on the full sample.

The bottom panel of Table 4 shows that the compliance gap is very low for PAYE, between almost 0 per cent to 2 per cent.[18] This high compliance can be explained by the presence of third-party reporting of wages through the employer (e.g. Kleven et al. (2011) find that income tax evasion is almost zero under third-party reporting).[19] In general, non-compliance appears to be widespread outside Kigali and for small and medium taxpayers. Lower compliance in these groups mirrors the lower audit rates experienced by these groups of taxpayers, which may result in a more relaxed attitude towards tax compliance.

Table 4 also shows that the compliance gap is generally lowest for large and top-medium taxpayers, where audits are more likely to occur (compare audit rates in Table 3). If we check the correlation between the audit probability and the compliance gap of the individual taxpayer, we find a negative relationship for PAYE, as well as for the PIT and CIT real

[18] The compliance gap for small and medium PAYE taxpayers outside of Kigali is slightly negative, as some taxpayers received a tax credit as a result of an audit. This may be due to some cases where taxpayers mistakenly declare too high taxes.

[19] Nevertheless, employers may still have an incentive to under-report their contributions to the national social security fund (NSF).

regimes.[20] This indicates that compliance is lower when audit efforts are lower. Nevertheless, the correlation is only significantly different from zero at the 1 per cent level for the PIT real regime (–0.28). The lack of statistical significance for VAT, PAYE and the CIT real regime, however, could also be due to relatively low statistical power of this calculation (due to the small number of audits). Moreover, given the tax type, the size and location of the taxpayer, the RRA is more likely to audit a risky taxpayer from which it expects a higher level of income misreporting. This endogenous selection of audits by the RRA may thus counterbalance the negative relation between the audit rate and the individual compliance gap (and reduce the observed correlation between the two). In other words, the actual, partial, effect of the likelihood of an audit on the individual compliance behaviour is expected to be higher than reflected by the correlation coefficients.

Column (3) of Table 4 shows that the compliance gap increases for CIT, PIT, and VAT if we weight the respective compliance rates by population. The reason for this increase in the compliance gap is that the likelihood of an audit varies by size and location of the taxpayer (which is not considered in the calculation of the upper bound scenario). While only less than 5 per cent of taxpayers under the PIT real regime are large and top-medium taxpayers, a high share of the overall number of audits take place in this group of taxpayers. In the weighted upper bound scenario, large taxpayers receive a relatively smaller weight in the calculation of the overall compliance gap, while small taxpayers get a higher weight to reflect their respective share in the population. As the compliance gap of small and medium-sized taxpayers in Kigali under the PIT real regime is 84 per cent (see second column of Table 4) and since this group now receives a higher weight, the overall compliance gap in the PIT real regime increases to more than 70 per cent. Similarly, the weighted compliance gap for CIT, VAT, and PAYE increases, as small and medium-sized taxpayers misreport higher shares of their income.

Finally, it must be noted that the range of estimates for the compliance gap under different scenarios is very wide. For the CIT and PIT real regime, the estimates' range is higher than 60 percentage points, which may cast doubt on the practical relevance of some of these scenarios, particularly the lower bound one. Even the estimated compliance gaps under the upper bound and weighted upper bound can only be taken as indicative. They are perhaps more useful for making comparisons across tax type and taxpayer type than to evaluate the precise extent of underreporting per se. Overall, the wide range of estimates for the compliance gap under the various tax types, size and regimes shows that it is difficult to assess compliance levels using existing administrative data in developing countries that do not use randomised auditing. However, the exercise remains useful in highlighting the limitations of the data for analysing compliance, and the importance of experiments for such purpose.

3.2.3 Nil-filers and firms reporting losses

Table 5 presents figures on firms reporting losses and nil-filers, as defined in Section 1.3, disaggregated by tax types and some taxpayer characteristics.

Losses are particularly reported by firms in the real regime, where taxpayers file detailed accounts and can therefore report losses, with all the related information on costs and income. Indeed, 17.5 per cent and 34.6 per cent of taxpayers in the PIT and CIT real regime, respectively, report losses. On the contrary, these figures are negligible for other regimes, where nil-filing is more common (see second and third columns of Table 5). Furthermore, the

[20] First, for each tax type, we regress the firm's size (a binary variable, which takes the value one if the firm is large or top medium and zero otherwise), and location (a binary variable, which takes the value one if the firm is registered in Kigali and zero otherwise) on a dummy variable indicating whether the taxpayer was audited (for the tax periods 2012 and 2013). Then, we take the predicted audit rates from this logit regression. Finally, we check the correlation between the compliance gap of the audited firms and the predicted audit rates.

lump-sum regime is more affected by nil-filers, as firms are unable to declare losses (but can declare zero income). The flat-amount regime suffers less from both issues, because taxpayers are required to file a positive amount.

Table 5 Firms with non-positive income (2012 and 2013)

	(1) Share of nil-filers (%)	(2) Share of firms with losses (%)	(3) Share of firms with non-positive income (%)
PIT real regime	9.5	17.5	27.0
PIT lump sum	12.5	0.0	12.5
PIT flat amount	2.5	0.0	2.6
CIT real regime	13.2	34.6	47.7
CIT lump sum	46.5	0.0	46.5
CIT flat amount	10.4	0.1	10.5
VAT	35.4	0.0	35.4
PAYE	1.3	0.0	1.3
Large and top-medium	0.6	0.6	1.2
Small and medium, Kigali	18.2	1.1	19.3
Small and medium, outside Kigali	8.4	0.2	8.6

Note: Column (1) shows the ratio of taxpayers with no taxable income to the total number of taxpayers. Column (2) shows the ratio of taxpayers with losses to the total number of taxpayers. Column (3) shows the ratio of taxpayers with no income or losses to the total number of taxpayers. The bottom three categories (i.e. large and top-medium; small and medium, Kigali; small and medium, outside Kigali) refer to tax declarations from CIT, PIT, VAT, and PAYE.

Looking at the aggregate incidence of nil-filers and losses across regions, Table 5 shows that 19.3 per cent of small and medium taxpayers in the province of Kigali do not declare a positive taxable income – neither for CIT and PIT nor for PAYE and VAT. In comparison, only 1.2 per cent of large and top-medium taxpayers in Kigali do not state a positive taxable income. Lastly, the bottom of column (1) in Table 5 shows that nil-filing is most common among small and medium-sized companies, which are less likely to face an audit by the RRA than larger firms (as turnover is a criterion used by the RRA audit department; see also column (1) of Table 3 above). The remainder of this paper will only investigate the sample of firms with positive income (see description of the sample in the last column of Table 8 in the Appendix).

3.3 Effective tax rates

In this section, we perform a basic investigation of progressivity based on the ETRs across the income distribution, based on income data from PIT and CIT returns. Table 6 shows the average ETRs by deciles, calculated on the basis of overall income, for each PIT regime type as well as for the CIT real regime.[21] The first column shows that the ETR of the poorest decile of the flat-amount regime is 20.6 per cent, while the top decile pays 2.1 per cent as a share of income. Therefore, the flat-amount regime seems to be largely regressive. However this issue is largely confined to the first decile, and the regressivity is partly due to the design of the flat-amount regime. The maximum amount of tax payable for the richest taxpayers is RWF 300,000, which naturally represents a smaller percentage of income as the latter increases. At the same time, the strikingly high ETR in the bottom decile is due to the fact that the flat tax of RWF 60,000 is applicable to all income below RWF 4 million. Therefore, it impacts on low incomes more heavily, representing a larger share as income decreases.

[21] Given the low revenue from the CIT lump-sum and flat-amount regime (see Figure 4), we do not discuss the ETR for these regimes here. However, a comparison of Table 6 and Appendix Table 8 suggests that the ETRs for the respective CIT and PIT regimes are distributed in a relatively similar way.

Table 6 Effective tax rates based on overall income (%, 2012 to 2014)

Decile	(1) PIT flat	(2) PIT lump sum	(3) PIT real	(4) CIT real
1	20.6	3	2.2	3.0
2	2.7	3	1.2	1.6
3	2.7	3	1.3	1.6
4	2.8	3	1.2	1.4
5	2.6	3	1.4	1.5
6	2.3	3	1.5	1.8
7	2.0	3	1.5	1.4
8	1.6	3	1.0	1.4
9	2.3	3	0.8	1.4
10	2.1	3	0.7	1.5

Notes: The deciles are calculated on the basis of PIT and CIT overall income, respectively, of the sample of firms with positive income. Columns (1) to (4) indicate the average ETRs by decile, which reflect the amount that each decile paid on average in taxes as a share in overall income. Column (1) indicates the ETRs for the PIT flat-amount regime and column (2) indicates the ETRs for the PIT lump-sum regime. Column (3) and (4) indicate the ETRs for the PIT and CIT real regime, respectively. In general, we only include taxpayers with an overall PIT and CIT income higher than RWF 10 and RWF 100, respectively, which does not affect our estimates except for the first decile of the PIT flat-amount regime (where the average ETR would be 1,300% due to these outliers). Coefficients in bold indicate that the ETRs in the respective decile is different from the 3% tax of the lump-sum regime at the 1% significance level (two-sided *t*-tests).

Column (2) of Table 6 simply confirms the flat-tax rate of 3 per cent of overall income that is used for firms in the lump-sum regime. Notably, the ETRs in the lump-sum regime are higher than in the flat-amount regime in all deciles except the first one, and this difference is statistically significant.[22] The third column of Table 6 shows that the average ETR in the bottom PIT decile of the real regime is 2.2 per cent. In comparison, the richest decile is only required to pay 0.7 per cent of its overall income. As the lowest tax rates can be found for the top three deciles and the highest tax for the poorest decile, PIT is largely regressive in the real regime. The CIT real regime is slightly regressive, since the poorest taxpayers in the CIT regime face the highest ETR with 3 per cent, while the ETR for taxpayers in other deciles is around 1.5 per cent (see the fourth column of Table 6).

Interestingly, the lowest ETRs across regimes are found in the PIT real regime, which are significantly lower than the ETR for the lump-sum regime (3 per cent) and for the flat-amount regimes – as confirmed by statistical *t*-tests.[23] In other words, taxpayers in the real regime have a substantially lower tax burden than taxpayers in the flat-amount and lump-sum regime, which is a result of non-taxable income and tax benefits, such as tax discounts and deductions in the real regime. The explanation for this discrepancy could be twofold. A first possibility is that taxpayers in the lump-sum regime are not aware that they could benefit from lower ETRs in the real regime. The second possible explanation is that they take into account facing a higher ETR, because this allows them to benefit from less stringent reporting requirements and from a minimal probability of being audited. In other words, taxpayers may make a rational calculation of the benefits (lower ETR) and the costs (higher probability of audit, higher compliance costs associated with filing full accounts) of switching to the real regime, and decided against it. Thus, the regime under which taxpayers declare their taxes may be an indicator of compliance behaviour as well as compliance costs. Small companies that are subject to the lump-sum regime can in principle voluntarily opt for the real regime, and consequently potentially be better off thanks to a lower tax burden. However, small taxpayers may find it difficult to put together the more detailed information required in the real regime, due to capacity constraints and to limited access to good tax advisors. This would imply a potentially large compliance cost that is typically regressive in developing countries, as documented in Coolidge (2012).

[22] The *p*-values of two-sided *t* tests for equal means are below the 1% significance level.

[23] The *p*-values of two sided *t*-tests are always below the 5% significance level.

As far as regional differences are concerned, the average ETR in Kigali (1.5 per cent) is significantly higher than the rate of 1 per cent in other Rwandan provinces. These differences persist if we exclude large and top-medium firms registered in Kigali (*p*-value of two-sided *t* test is lower than 1 per cent).

Table 7 reports the ETRs defined as the ratio of tax due to taxable income, as opposed to overall income (as in Table 6). In this case, the rates are 9 per cent for the bottom decile of the PIT real regime, and higher than 26 per cent for the top decile (see column (1) of Table 7). The ETRs are larger under this definition, since taxable income is considerably smaller than overall income due to deductible expenses, allowances and other deductions. Importantly, and naturally, ETRs defined using taxable income reflect more closely the progressive structure of the law and indeed imply a higher tax burden for larger firms. As PIT payments are based on taxable income, the ETR as a share of taxable income converges to the highest marginal tax rate of 30 per cent for high incomes (see income tax rates in Section 2). Comparing the ETRs under the different income definitions, we see that PIT real regime may be progressive on paper (when taxable income is the dominator in the ETR calculation, as in Table 7), but may be regressive in practice (when overall income is used, as in Table 6). This may be due to lower take-up of deductions and other tax benefits amongst smaller firms, which define the difference between the two denominators in Table 6 and Table 7 – overall income and taxable income, respectively.

Table 7 Effective tax rates based on taxable income (%, 2012 to 2014)

Decile	(1) PIT real	(2) CIT Real
1	9.0	29.6
2	11.4	29.7
3	14.1	29.9
4	15.6	29.9
5	18.0	29.9
6	19.4	29.9
7	20.8	29.8
8	22.6	29.9
9	23.7	29.8
10	26.3	29.8

Notes: The deciles are calculated on the basis of PIT overall income of the sample of firms with positive income. Columns (1) to (2) indicate the average ETRs by decile, which reflects the amount that each decile paid on average in taxes as a share in taxable income. Column (1) indicates the ETRs for the PIT real regime and Column (2) indicates the ETRs for the CIT real regime.

The second column of Table 7 shows that the ETR as a share of taxable income is close to 30 per cent in all CIT income deciles, which is expected as CIT is levied at a flat rate of 30 per cent in the real regime (yet lower tax rates may apply for young firms; see Section 2 for details). While the CIT rates are proportional to taxable income, the ETR as a share of overall income is highest for the poorest decile and thus regressive (compare Table 6 and Table 7).

4 Concluding remarks

Although this paper is only a first, descriptive account of preliminary results, it reveals a few interesting facts about taxation in Rwanda. For example, we have shown that tax revenue in Rwanda is highly reliant on large taxpayers in Kigali, with about 85 corporations contributing more than half of total CIT revenue. At the same time, 86 per cent of revenue comes from taxpayers registered in Kigali.

Moreover, the data shows that audit rates are quite low in Rwanda, as in many other countries, but there are some categories of taxpayer for which an audit is extremely unlikely. These are particularly small taxpayers outside of Kigali, and firms under the flat-amount and lump-sum regimes. While it is tempting to provide a policy recommendation to increase audit rates for these categories, it must be noted that the revenue implications of doing so would almost certainly be disappointing. These taxpayers are likely to generate small amounts of revenue, and the cost of aggressively enforcing the law for a large number of small taxpayers may be more than its revenue benefits. While this does not amount to an argument against more uniform enforcement, it is a consideration of the costs and benefits of different enforcement strategies. Clearly audits are not the only available tool, as new technologies are already offering alternative options to encourage higher compliance. Examples of these applications are the introduction of EBM machines for VAT payments, and the mobile platform for facilitating filing returns for small taxpayers.

Despite the ongoing efforts, non-compliance seems to be substantial. However, our range of estimates under different scenarios varies widely from a lower bound of 0.1 per cent to an upper bound of more than 67 per cent, depending on the tax type. Cross-firm comparisons can, however, give a more nuanced picture. Under third-party reporting (PAYE) and where enforcement efforts are higher, such as for large taxpayers and for VAT, compliance gaps are considerable lower. This is probably due to a deterrence effect triggered by larger enforcement efforts of the RRA in these groups.

In addition, the data allows some preliminary considerations on progressivity: when we consider overall income, smaller taxpayers seem to pay relatively more. While this result has to be considered in the context of larger tax evasion by small taxpayers, it still points to a possible element of regressivity in the way the income tax system works in practice.

These preliminary results will be used as a stepping stone for more research on tax compliance. In particular, two further studies build directly on the descriptive account presented here (Mascagni et al. forthcoming a; Mascagni et al. forthcoming b). Both of them are based on experimental research that builds on the basic facts presented here to provide more robust evidence on policy options that the RRA may adopt to increase compliance. This paper, while being a starting point, has allowed us to quantify phenomena that are known, such as audit probabilities, compliance gaps and tax burdens, but for which we previously had little evidence. We hope this paper can be a first step in providing further evidence to support policy, and to show the potential of using tax return data for research.

Finally, although the results presented here are strictly applicable only to Rwanda, they seem in line with the situation in other low-income countries in Africa. For example, the following issues, documented here, are often present in other countries: the large share of taxpayers declaring non-positive income, the high concentration of tax revenue obtained from large taxpayers, low audit probabilities for small taxpayers, and regressive aspects of the tax system in practice. In terms of data availability and quality, the RRA has certainly been at the forefront of the recent movement towards using administrative data for research. In addition, the RRA is a relatively consolidated administration, having been established almost twenty years ago. Revenue administrations in other countries may be younger and less ready to engage in this area, both in terms of data quality and openness to collaboration with researchers.

Appendix

Table 8 Sample by year and tax type

	(1) Full sample	(2) Sample of firms with positive income
Fiscal year 2012		
PIT	36,413	29,726
CIT	9,727	6,063
VAT	8,678	5,703
PAYE	12,312	12,189
Total	**56,598**	**46,435**
Fiscal year 2013		
PIT	35,170	34,271
CIT	11,371	7,461
VAT	10,416	6,625
PAYE	12,834	12,638
Total	**58,022**	**52,956**
Fiscal year 2014		
PIT	25,627	23,078
CIT	19,346	9,013
VAT	12,565	8,230
PAYE	12,747	12,420
Total	**55,412**	**43,490**

Notes: Total refers to taxpayers who have a PIT, CIT, VAT, and/or PAYE account. Column (2) only includes firms with positive income.

Table 9 Effective tax rates based on overall CIT income (%, 2012 to 2014)

Decile	(1) CIT flat amount	(2) CIT lump sum
1	**2.6**	3.2
2	**3.0**	3
3	**2.9**	3
4	**2.6**	3
5	**2.2**	3
6	**1.7**	3
7	**2.1**	3
8	**2.3**	3
9	**2.1**	3
10	**2.5**	3

Notes: The deciles are calculated on the basis of CIT overall income of the sample of firms with positive income. Columns (1) to (2) indicate the average ETRs by decile, which reflects the amount that each decile paid on average in taxes as a share in overall income. Column (1) indicates the ETRs for the flat-amount regime. Column (2) indicates the ETRs for the lump-sum regime. In general, we only include taxpayers with an overall income higher than RWF 100, which does not affect our estimates except for the first decile of the flat-amount regime (where the average ETR would be 509% due to these outliers). Coefficients in bold indicate that the ETRs in the respective decile is different from the 3% tax of the lump-sum regime at the 1% significance level (two-sided *t*-tests). Several taxpayers in the lowest CIT lump-sum decile seem to pay the flat-amount of RWF 60,000, and, therefore, the average ETR of this decile is slightly higher than 3%.

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International Centre for Tax and Development
at the Institute of Development Studies
Brighton BN1 9RE, UK
T: +44 (0)1273 606261
F: +44 (0)1273 621202
E: info@ictd.ac
www.ictd.ac